Ministry
of
Transportation
Ontario

MI-119

EVALUATION OF HOT MIX PAVEMENT MODIFIED WITH POLYESTER FIBRES

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

EVALUATION OF HOT MIX PAVEMENT MODIFIED WITH POLYESTER FIBRES

INTERIM REPORT

NUMBER 1

BY

R.C. EVERS
P. KORGEMAGI
D.F. LYNCH

ENGINEERING MATERIALS OFFICE

BITUMINOUS SECTION

APRIL 1988

IBSN 0-7729-4224-2

SUMMARY

In 1987 the Ontario Ministry of Transportation constructed a trial of hot mixed, hot laid, asphaltic concrete, modified by the inclusion of short polyester fibres called BoniFibers B. The objective was to determine, among other things, if polyester fibre modified mix will resist cracking and rutting in a severe environment.

The trial was constructed over a badly cracked, high volume section of highway subject to considerable truck traffic.

This report presents the results of preliminary work performed in the laboratory, during construction, subsequent testing and observations over the first winter in service.

The trial has demonstrated that compared to an adjacent control mix the polyester fibres have had a positive impact in preventing cracks in the hot mix over the first winter.

INDEX

	PAGE
INTRODUCTION	1
LABORATORY MIX TRIAL	1
FIELD TRIAL	2
TESTING	5
FIELD EVALUATIONS	7
COSTS	8
DISCUSSION	8
APPENDIX	

1 INTRODUCTION

In 1986 Kapejo Inc. of Wilmington, Delaware, U.S.A. suppliers of BoniFibers, along with Canadian distributor Fibrelink Systems Inc., approached the Ministry to construct a trial section of hot mix paving incorporating their product.

BoniFiber B reinforced hot mix, it was claimed, would resist reflection cracking, thermal cracking, rutting, shoving and pot hole formation.

BoniFibers B are 100% polyester produced in the U.S.A. by continuous melt-spinning. Properties are:

Length 6.35 mm
Diameter 0.020 mm
Mass Density 1.32 to 1.40
Melt Temperature 249°C minimum
Tensile Strength Break Elongation 33% ± 9%

The fibres are added at the rate of 2.50-3.75 kg/t of dense graded hot mix, depending on traffic volume. The distributor supplied the Ministry with the names of several U.S. authorities and contact persons who had or were using the product. Also provided were project reports from some of these authorities.

The Ministry agreed to conduct laboratory analysis of mixes incorporating BoniFibers and subsequently a field trial.

2 LABORATORY MIX TRIAL

2.1 Run No.1

Two HL-3 mix designs were performed in the laboratory with different aggregates. Each of the two designs were performed in triplicate; one without fibres (the control), one with 0.25% fibres and the other with 0.38% fibres.

The distributor of the fibres stress the need for an extended dry mixing cycle to incorporate the fibres with the aggregate. To allow for cooling during the extra mixing time, the aggregates and fibres were premixed by hand and put in an oven overnight at a temperature 14°C above the normal 170°C. The next day, the aggregates and fibres where mechanically mixed dry for 2 min, as opposed to the normal 5 s, before addition of asphalt cement and a wet mixing cycle of 45 s. The fibres were observed to clump up around the mixing paddle.

Marshall briquettes were formed at three asphalt contents for each mix and tested for Marshall values.

The Marshall stability of fibre modified mix was found to be less than the control for both mix designs at each asphalt content. This was contrary to the claims made for fibre modified mix by the distributor.

The distributor explained that the lower stabilities must be the result of inadequate mixing in the laboratory. This was probably true since the Hobart mixers used in the laboratory are not nearly as efficient as a pugmill mixer with its high shear.

2.2 Run No.2

Mix number one was then rerun with the fibres being mechanically premixed with the aggregates for 2 min prior to placement in the oven overnight. The rerun was performed with 0.25% fibres only. During the dry mixing cycle the next day, the fibres dispersed into the mix much better.

The stability of the rerun mix exceeded the stability of the control mix at all asphalt contents. Figure 1 represents the Marshall values obtained on mix number one.

3 FIELD TRIAL

3.1 Criteria

Fibrelink Systems Inc. requested that a field trial of fibre modified mix be constructed where:

1. Traffic volume exceeds 15,000 AADT per lane;

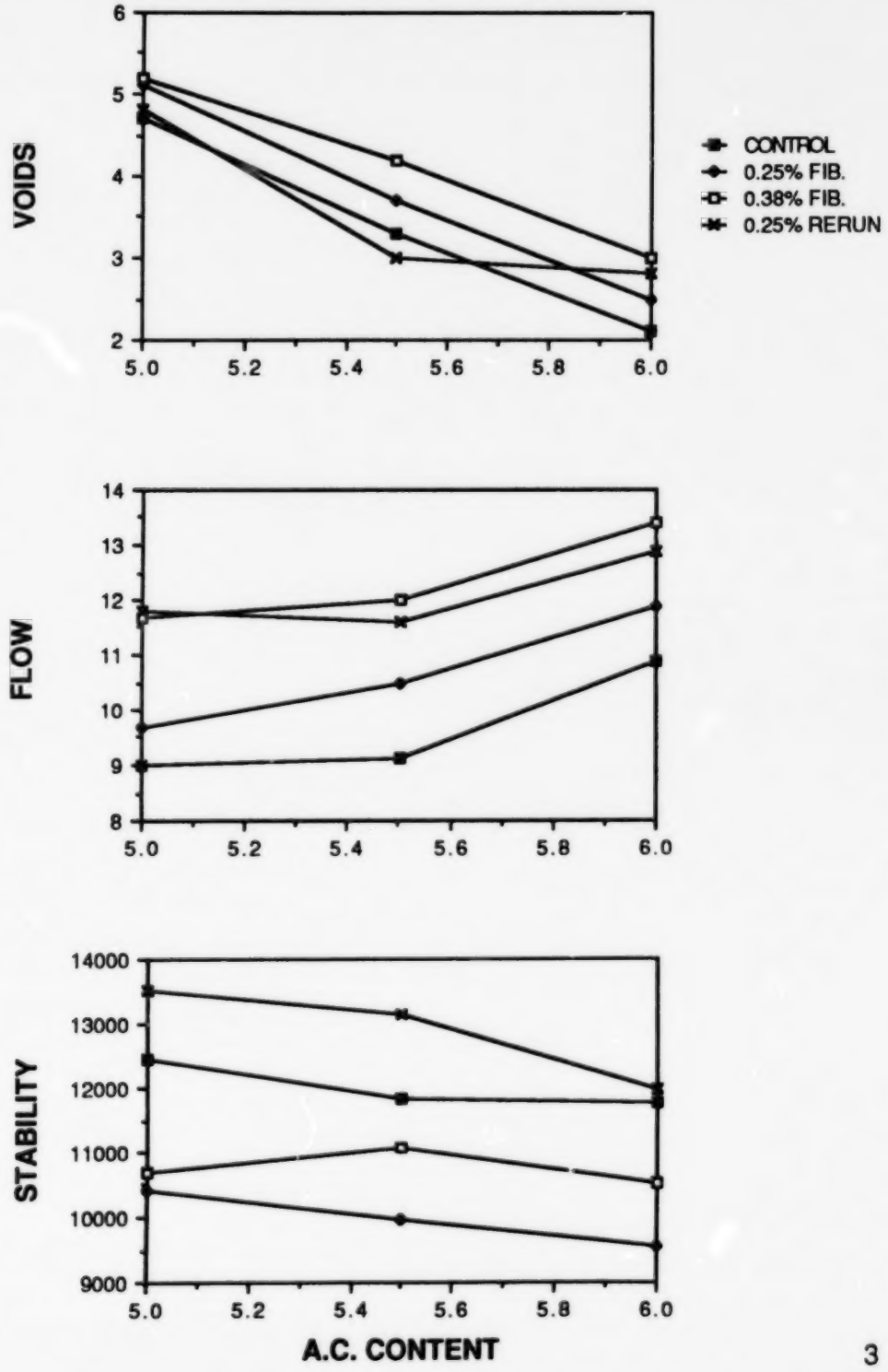
2. Mix to be place on badly cracked existing pavement where reflection cracks could be expected;

3. Mix to be placed beside unmodified hot mix as a control;

4. The length of the trial to be greater than 150 m.

The distributor desired this worst case scenario in order to provide a severe environment for evaluation.

FIG. 1: BONIFIBRE TRIAL MIX #1 MARSHAL VALUES



3.2 Location

A section of Hwy. 403 in Burlington with 60,200 AADT (1986) was selected for the trial. As part of Burlington District's hot mix patching contract 87-545, a 300 m long patch was to be constructed in the east bound lanes just east of Waterdown Rd. The east bound lanes at this location are three lanes wide with a fully paved shoulder. All three lanes and shoulder were to be patched.

3.3 Pavement Condition

The right lane was selected for the BoniFiber trial with the centre, left lanes, and paved shoulder as control sections. The centre and right lanes were extensively cracked with much fatigue cracking in the right lane. The original condition crack survey is contained in Appendix I.

3.4 Mix Design

The HL-1 patching mix design consisted of:
50% coarse aggregate (Steetley steel slag),
50% fine aggregate (Cloverdale sand),
5.7% 85-100 grade asphalt cement (by weight of aggregate).

This mix was modified for the trial by the addition of 0.357% BoniFibers by weight of aggregate (3.6 kg/t) and an increase in the asphalt content from 5.70 to 5.95 %. The extra asphalt cement was specified by the distributor to coat the fibres.

3.5 Mixing

The mix was produced at King Paving's batch plant in Burlington on 87 09 23. This plant was equipped for recycling with a conveyor for the reclaimed material to the weigh hopper. This conveyor was used to load three 3.4 kg polyethylene bags of fibres into the weigh hopper for each 2,858 kg batch (the polyethylene bags melt in the mixer). A man was stationed on the mixer platform of the plant to make sure the bags of BoniFibers dropped into the pugmill. Both the control and BoniFiber mixes were batched between 150 and 170°C. The dry mixing cycle was extended from 6 s for the control mix to 30 s for the fibre mix. The wet mixing cycle remained the same for both mixes at 30 s. No problems were encountered producing the BoniFiber mix at the hot mix plant.

3.6 Mix Placing

The centre and left lane were paved first with the control mix and then the right lane with the BoniFiber mix. The control mix laid well and compacted to a tight uniform surface. When the crew switched to the modified mix and tried to make the starting joint, it proved to be quite difficult. The BoniFiber mix was very cohesive making raking out of the stones to feather the joint a challenge. Although being laid at 40 mm or better, the machine laid BoniFiber mix had a torn open texture on the outsides as though the mix was being laid too thin. Adjustment of the screed reduced the tearing slightly but the mat was still unsatisfactory. The mat was generally more open on the left side next to the centre lane. Several small areas of the mat were deficient in mix down to the depth of one stone.

The contractor's superintendent commented that the BoniFiber mix handled like an under-asphalted asbestos modified mix.

3.7 Compaction

Rolling was carried out with a Dynapac CC-42A breakdown roller operated in vibratory mode, followed by a Hyster 14 t static finishing roller. The BoniFiber mix took on a muddy water appearance under compaction whereas the control mix maintained a normal black colour. The compaction equipment did not close up the open, torn texture on the BoniFiber mat.

4 TESTING

4.1 Laboratory Testing

The laboratory responsible for acceptance testing on this contract, had performed seven extraction tests on the control mix as of the date the trial was constructed. This testing indicates the control mix was "under-asphalted" by an average 0.29%. The sand/stone ratio and the minus 75 µm content were within acceptable tolerances.

Five samples of the BoniFiber modified mix were extracted in the Downsview laboratory and showed the mix averaged 0.26% less asphalt than design. Although testing confirms that the contractor added the required extra 0.25% A.C. to the BoniFiber mix, the starting point was too low. Table I summarizes the extraction results from both mixes.

Two of the samples were tested for penetration and viscosity of the recovered asphalt. The average penetration was 55, viscosity 470.8 mm^2/s -- normal values for an 85-100 grade asphalt cement. Five samples of the modified mix were tested for Marshall values. The results are presented in table 2.

TABLE 1: EXTRACTION RESULTS

	CONTROL MIX		BONIFIBER MIX	
	% A.C.	+ 4.75	% A.C.	+4.75
TARGET	5.70	50.1	5.95	50.1
SAMPLE				
1	5.59	45.2	5.56	49.4
2	5.45	50.8	5.57	50.0
3	5.42	50.5	5.87	47.2
4	5.42	44.8	5.66	49.4
5	5.35	47.6	5.77	47.9
6	5.18	48.2		
7	5.49	51.1		
MEAN	5.41	48.3	5.69	48.8
ST.DEV.	0.13	2.62	0.13	1.18

TABLE 2: BONIFIBER MIX MARSHALL VALUES

SAMPLE	VOIDS	FLOW	STABILITY
1	2.9	13.8	15999
2	3.7	16.0	13647
3	3.8	16.2	12721
4	2.8	12.9	12669
5	2.8	16.4	13101
MEAN	3.2	15.1	13627.4
ST. DEV.	0.50	1.60	1382.21

4.2 Friction Testing

In October of 1987, friction testing of the patch area containing BoniFibers and the control mix was conducted. The BoniFiber mix had an average SN of 34.9, whereas the control mix had an average SN of 26.5. The existing mix beyond the patch had average SNs of 37.2 and 39.4 for the centre and right lanes respectively.

5 FIELD EVALUATIONS

5.1 SEPTEMBER 28 1987

Five days after construction, the BoniFiber mix looked whitish in comparison to the control mix on either side. A few small fat spots were observable near the start of the fibre modified patch. Overall, the modified mix was very open textured compared to the control mix which was tight to very tight in the wheel tracks.

5.2 JANUARY 27 1988

On this day the ambient temperature was -15°C±. The center lane, constructed with the control mix, contained 35 slight (2 mm wide) transverse cracks and had longitudinal cracking for about 30% of its length. Transverse cracks in the center lane stopped at the edge of the BoniFiber mix. Less cracking was evident in the left lane. The right lane containing the BoniFibers had only 3 slight transverse cracks and no longitudinal cracking. One of the transverse cracks is associated with a culvert and extends across all lanes of pavement including the west bound lanes on the other side of the grass median.

5.3 APRIL 7 1988

On this day the ambient temperature was 6°C±. Some of the cracks previously observed in the control lanes were no longer visible and only two of the three cracks in the BoniFiber mix were now discernable. The crack associated with the culvert was closed completely.

6 COSTS

Fibrelink Systems Inc., supplied the BoniFibers for the trial at no cost to the Ministry. King Paving and Materials Company, charged an extra $165.98 ($1.65/t) for the extra asphalt cement and labour associated with the trial construction.

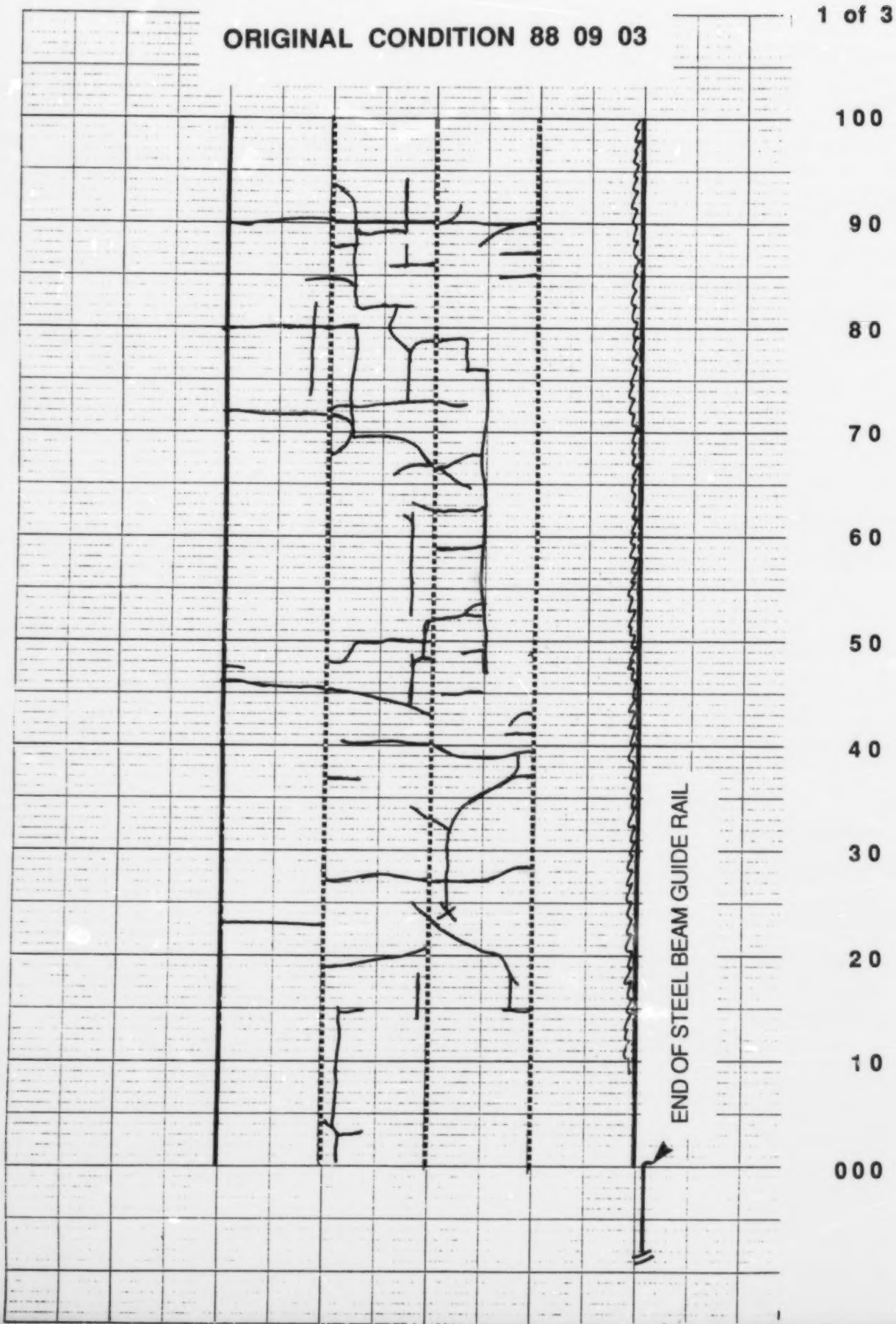
The estimated extra cost to produce a tonne of BoniFiber modified mix would be $0.55 for additional asphalt cement ($220.00/t) and $16.90 for the fibres ($4.73/kg), resulting in a total of $17.45 (1988 Prices). This figure does not include any premium that a contractor may charge to produce such a mix.

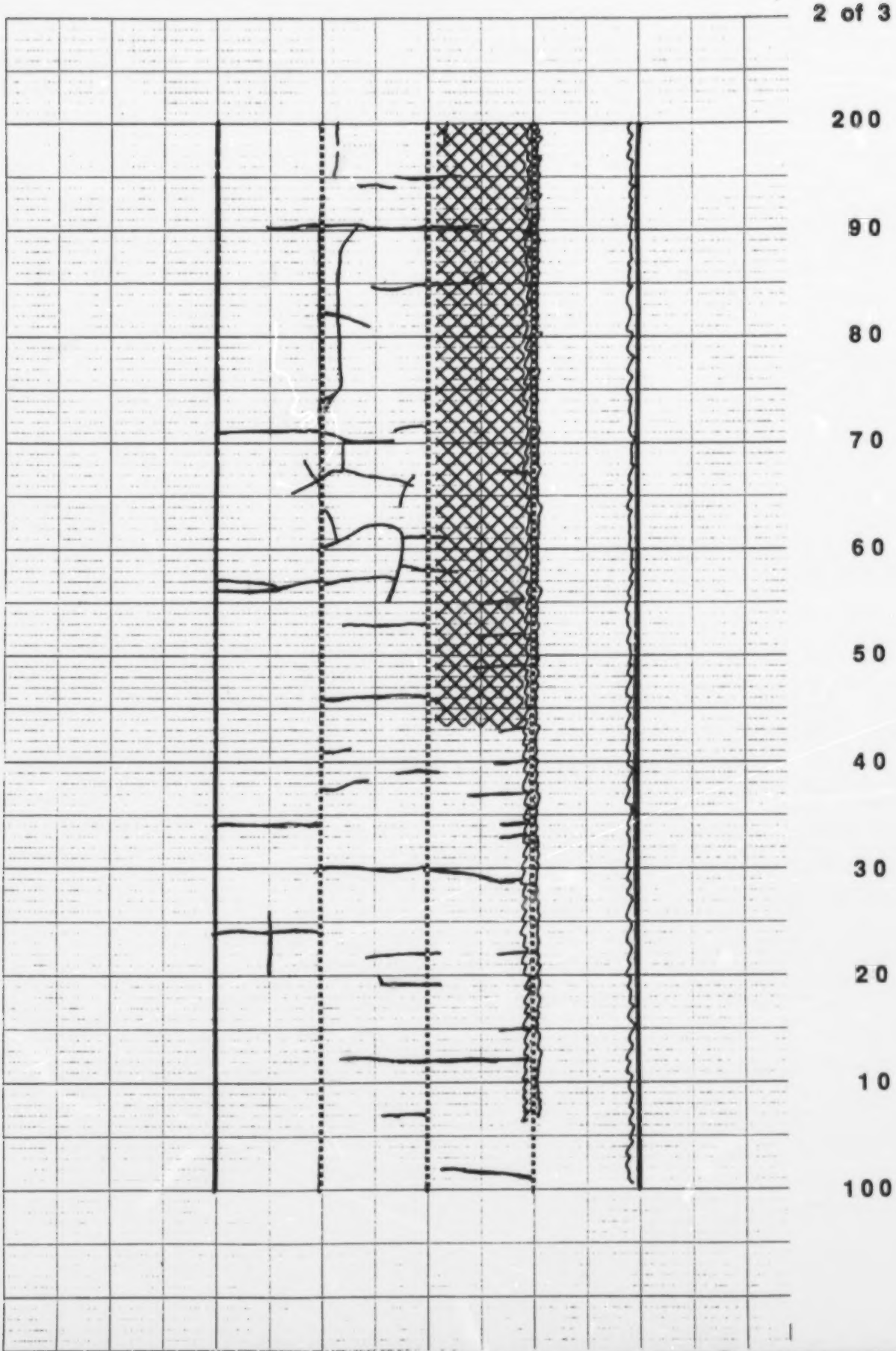
7 DISCUSSION

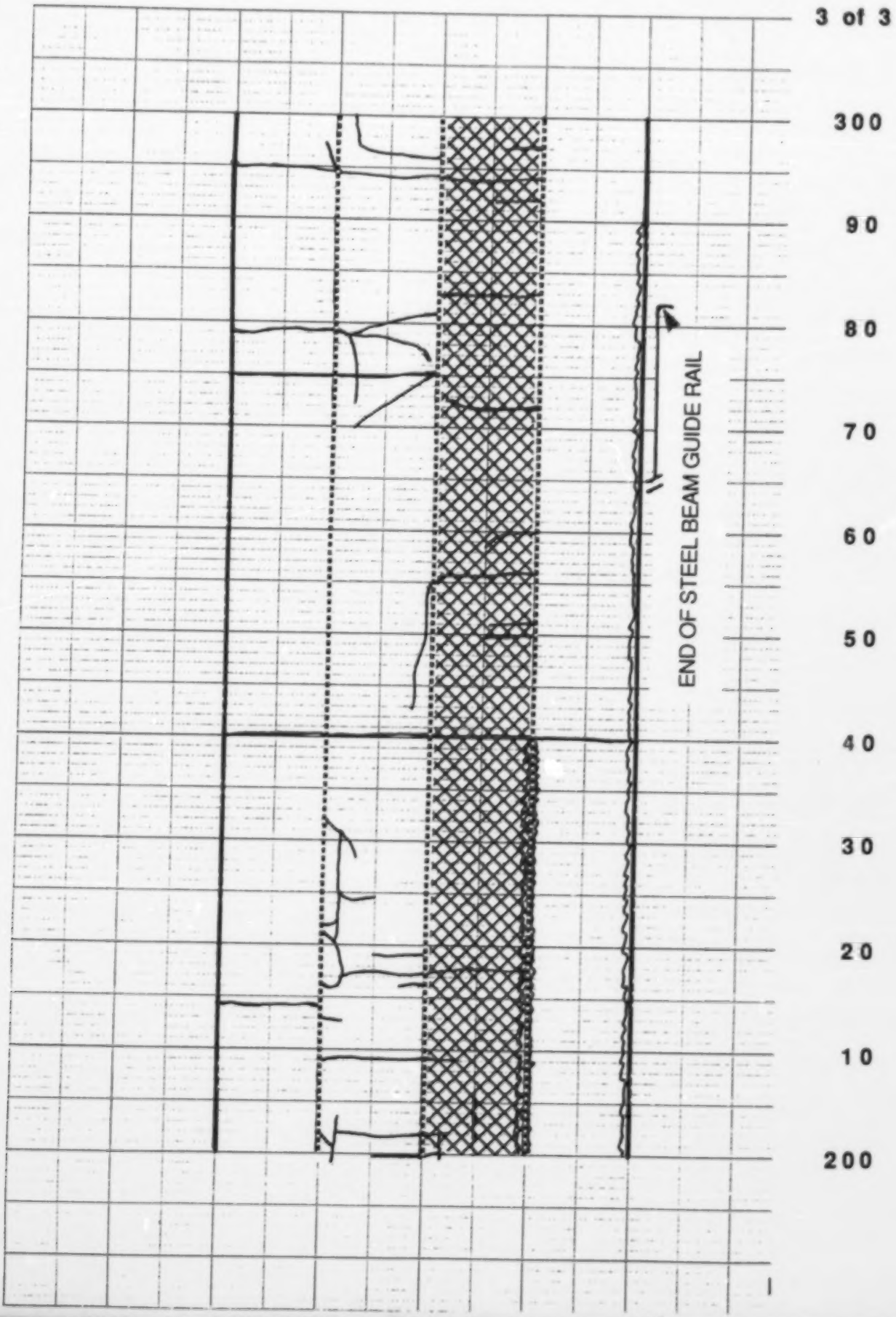
Laboratory testing confirms the observation that the BoniFiber mix behaved as though it was under-asphalted. The problem of the mix tearing under the paver screed would likely be reduced or even eliminated, had the mix contained the design asphalt content.

The coarse open texture of the BoniFiber mix likely contributes to the higher skid numbers over the control mix.

The BoniFibers have had a positive impact on retarding refection cracking in the short term, as demonstrated in the January and April 1988 evaluations.


ORIGINAL CONDITION 88 09 03
100
90
80
70
60
50
40
30
20
10
000
END OF STEEL BEAM GUIDE RAIL


200
90
80
70
60
50
40
30
20
10
100


300
90
80
70
60
50
40
30
20
10
200
END OF STEEL BEAM GUIDE RAIL